

Energy Efficient Low NO_x Water Heater

"As a leader in power-vented water heater technology, Rheem Canada Ltd. had an obligation to provide Canadian home owners with better water heater performance. Improved air quality from reduced emissions and lower heating costs from greater operating efficiency were key objectives. In pursuit of these goals we looked for and worked with some of the best technological minds in the industry."

Dan Robertson
General Manager, Rheem Canada Ltd.
Hamilton, Ontario

THE COMPANIES

Rheem Canada Ltd., located in Hamilton, Ont., manufactures electric and gas water heaters for residential and commercial markets. The company has been producing water heaters since 1948 and is one of three major suppliers to the Canadian market. Ontario gas utilities are significant users of the company's products.

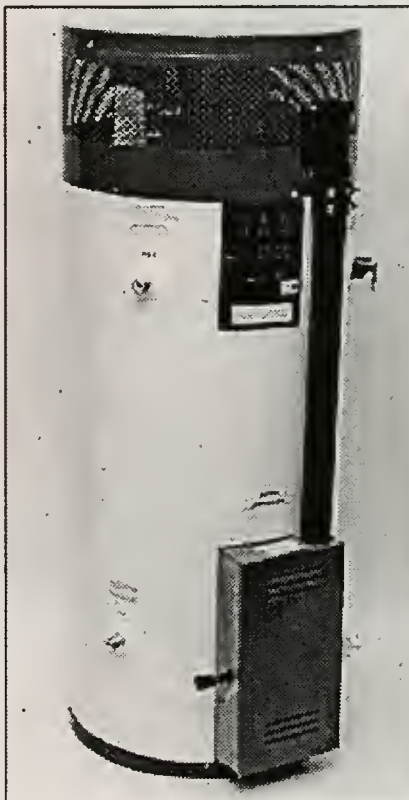
The Canadian Gas Research Institute (CGRI) has 20 years' experience in the development of combustion systems and maintains a completely equipped combustion laboratory.

THE CHALLENGE

Gas-fired equipment, which includes domestic appliances such as water heaters, is coming under stricter environmental regulation. Such equipment produces oxides of nitrogen during combustion; these compounds, known as NO_x, are hazardous when inhaled. In large amounts they also contribute significantly to urban smog.

New environmental legislation will set more rigorous standards for emissions which current burner designs for water heaters, space heaters and fireplaces will be unable to meet.

To maintain its leadership in the market, Rheem Canada wanted to build an improved water heater. The company retained CGRI to research and develop the new model.



Complete water heater.

PROJECT DESCRIPTION

In operation, a gas burner centrally located beneath the insulated storage tank delivers a thermal efficiency of about 75 per cent in an environment with no condensation. On average a 38,000 Btu/h burner will operate at this efficiency for 1.75 hours daily. Throughout the day, the need to maintain about 400 pounds of water at an average temperature of 135°F means a high heat leakage to the outside air. This standby heat loss drops the efficiency to about 0.55.

When Rheem contracted CGRI to improve the storage water heater, it had three concerns: efficiency, NO_x generation and air quality. CGRI felt that a radiant burner provided an immediate answer to all the concerns.

The conventional pressed steel burner, which is currently used in natural gas water heaters, transmits its

energy to the storage tank contents by the burner flame hitting the bottom of the tank and convection. A radiant burner releases much of its energy as radiant heat. Radiant heat instantly reaches the tank bottom (which acts as an effective heat sink) where it is completely or almost completely absorbed and conducted to the water. This mode of operation avoids high flame temperatures where immediate or prompt NO_x is formed. NO_x generation is immediately reduced by as much as 90 per cent - the optimum - depending on the type of radiant burner used.

The objectives of the project were to increase thermal efficiency by 30 per cent and reduce the generation of NO_x to around 10 ppm at three per cent oxygen, while retaining low carbon monoxide levels.

THE SOLUTION

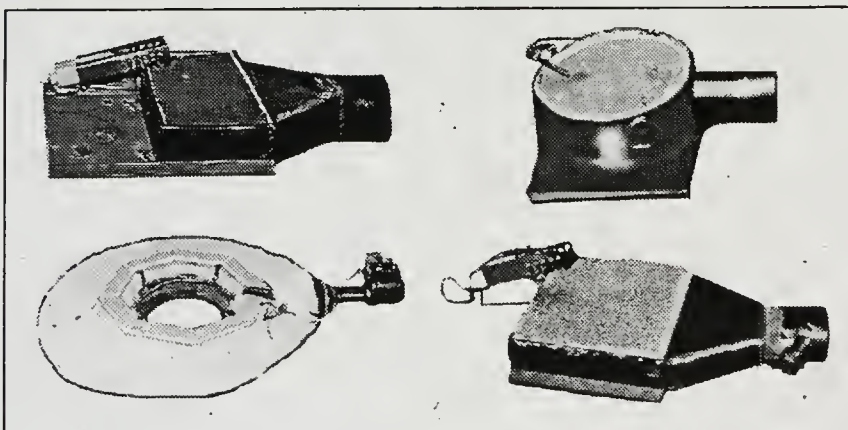
Radiant burner materials:

CGRI constructed and tested simple burners from a number of radiator materials. A method of installing the burner was devised which involved sealing and insulating the burner chamber, giving an immediate energy factor improvement.

Insulation:

The energy factor of a water heater is determined by the recovery of energy from the burner and the amount of standby heat loss (loss of heat when water sits in the tank after heating). Typically about 25 per cent of energy from the burner is wasted because of standby heat losses and flue gas emissions.

By insulating the sides and top of the tank with a single layer of one-inch thick specialized fibreglass, heat loss during burner on-cycles and standby heat loss were reduced by 23 per cent and the energy factor improved seven per cent. Another one inch of insulation would raise the energy factor by an additional eight per cent.



Family of Radiant Type Burners.

Burner thermal input:

In current traditional water heaters, 25 per cent of their energy (heat) is unused because of standby and flue losses. The burner imparts 47 per cent of its heat to the tank contents via the tank bottom. The balance, 30 per cent, is transferred via the flue.

With the move to a radiant burner with 38 per cent more energy being transmitted, heat transfer through the tank bottom actually increased to 63 per cent. Due to the use of an improved baffle, flue gas heat losses were reduced to 17 per cent.

RESULTS

The development of the new burner design demonstrated the following benefits:

- * the radiant type burner raises the energy factor of a traditional water heater by seven per cent;
- * closing the combustion chamber and utilizing outside air for combustion improves indoor air quality;
- * the radiant type burner lowers the production of NO_x by 75 per cent.

PARTNERSHIP IN POLLUTION PREVENTION AND RESOURCE CONSERVATION

Industrial companies located in Ontario may seek ministry/industry services that will help them to:

- * reduce, reuse and recycle solid waste;
- * reduce or eliminate liquid effluent and gaseous emissions;
- * use energy and water more efficiently.

Equipment and services supply companies can benefit from the information provided on technologies identified for business development.

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